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CONTENTS

AERONAUTICAL FIRMS WORK TO DEVELOP COMPOSITE MATERIALS

Rome SCIENZA & VITA NUOVA in Italian Jul 80 p 20

[Article by Paola De Paoli: "The Era of Composite Materials"]

[Text] Design flexibility, weight reduction, cost reduction and ease of construction, better resistance to fatigue and impact, absence of corrosion phenomena: these, in summary, are the principal positive characteristics of the composite materials, the use of which is opening up notable prospects of development for structures in the aerospace industry, replacing steel and light alloys.

The first experiments go back to the 1960's; in Italy, they are an advanced technology but one that has already been "proven" on the international level--a technology based mainly on the use of typical semifinished materials ("prepreg" = preimpregnated) available in various forms and qualities, depending on the specific characteristics of the piece required or of the production process. These semifinished materials--flexible in that they can be formed according to requirements and can therefore constitute laminates of several layers--undergo a polymerization process in an autoclave under special conditions of temperature and pressure, thus acquiring exceptional resistance and rigidity; they can be worked by machine for particular finished states, such as drilling and edging.

But all is certainly not so easy as it seems, as regards the production phase. For example, one of the main problems is indeed with drilling, inasmuch as the materials tend to crumble at the points subjected to the mechanical process. The technological development division of Aeritalia's transport-aircraft group has developed and patented new equipment and tools for production of carboresin components, the fibers that are becoming very widespread, along with other synthetic resins.

Aeritalia had been making glass-resin aircraft parts for prestigious foreign companies (Boeing, Douglas, Lockheed, etc) since the 1960's, and starting in 1973 began research and experimentation on carbon fibers, and made standard production-line parts (the controlled tab) for the G222 transport plane. With its participation in the Boeing 767 program (the wide-body twin-jet designed by the United States for medium-range transport), Aeritalia made from

carbon fibers an upper panel, 6 meters long, of the movable parts of the stabilizers--the biggest structure made of carboresins to date.

In the Boeing 767 program, the flight of the first prototype is planned for 1982, and deliveries to customers (to date there are already 150 planes ordered and 134 options) are scheduled from 1982 on. The sales forecast? A thousand planes, which at current prices is equivalent to 1.2 trillion lire worth of work for the national industry Aeritalia. Apart from the economic aspects, there is also the international prestige acquired with the reticular lattice structure that Aeritalia has made for the FOC (Faint Object Camera) space project of the ESA, within the framework of the American space-telescope project.

The composite materials are not the sole property of airplanes or space equipment. Their application to helicopter rotor blades is a meaningful goal, both from the technological point of view and as regards better use of the aircraft, inasmuch as it permits a 10 to 15 percent increase in the payload as compared with metal-blade technology.

In 1978, the Agusta group--Italy's leader in helicopters, as is known--started a "Composites Program" organized in three phases. The first comprises research to acquire deeper fundamental knowledge of the materials (physical, chemical and technological properties) and designing of blades, with the related testing of them.

The second phase--in parallel with design definition--is for building a "pilot center" in which to fabricate the blade prototypes and also improve the process methodologies and construction cycles.

The third phase--manufacturing--involves a suitable composites factory that will go up in the Frosinone area--specifically, in the commune of Anagni--and whose production activity is planned to start in 1982 with a work force of 234 persons, in addition to the researchers of the Pilot Center, who will transfer to the factory so as to make better use of resources and structures.

These multiyear plans of Aeritalia and Agusta give expertise to the industry through the talented commitment of our researchers.

11267
CSO: 3102

AID PROGRAM FOR FIBER COMPOSITE STUDIES

Stockholm TEKNIK I TIDEN in Swedish No 2, 1980 p 4

/Article: "STU Concentrates Heavily on Producing Swedish Know-How"/

/Text/ The STU /Technical Development Administration/ will spend a total of nearly 11 million crowns over 5 years to develop knowledge about light fiber composites. The ambition is to bring out a new material technology which could become very important within the advanced and greatly innovative engineering industry which Sweden needs in order to stay competitive in the future.

At the institutes of technology there is already adequate competence in important subareas involving fiber composites, just as there is at certain other institutions -- the Institute of Plastics and Rubber Technology, the FOA /Defense Research Institute/ and the Institute for Aircraft Technology, Saab-Scania. The intent is to establish coordination of the efforts in the field. This is the reason for the framework program.

Special efforts will be made in the following areas:

a) Fracture criteria during static and dynamic loads;

b) Damage increase with sustained loading;

c) Calculation methods for dimensioning of fracture;

d) Effects of curing conditions on the structural composition of the matrix;

e) Connections between structural composition and microscopic properties;

f) Environmental influence, in particular the effect of humidity.

During the first phase continuous fibers will be the prinicpal material studied, but the study of short fiber composites will gradually increase during the course of the program. The same applies to the division between cured plastic and thermal plastic matrices. Mechanical testing of fiber

composites and their components run parallel to in-depth studies of the connection between structure and bulk properties.

At a later stage the program will hopefully lead to a so-called contribution area for light fiber composites, an area which the STU will enter with a view toward supporting new products and production methods in the form of actual projects.

The framework program will be headed by a steering group of members from industry, institutes of technology and the STU. The results will be shown at annual seminars, which foreign experts will be invited to attend.

Parallel with the program, but completely independent, a study of health hazards connected with the manufacture and processing of fiber composites will be undertaken.

11949
CSO: 3102

NETHERLANDS ENJOYS GROWING COAL-PROCESSING INDUSTRY

Amsterdam ELSEVIERS WEEKBLAD in Dutch 19 Jul 80 pp 12-13

[Article by Piet De Wit: "The Golden Gleam of Coal Gas, or the Way the Netherlands Is Being Buried Under Energy"]

[Text] The Netherlands may well be thankful to the ayatollahs, the sheiks and all the other worldly and spiritual rulers in the Middle East. Their hunger for power, money and Islamic pride is indirectly responsible for the fact that tens of billions of guilders will be invested in our country in the next decade in the one bright star that has suddenly lit up in the otherwise dark skies of energy: coal gasification. In the meantime the price of energy has risen sufficiently high to bring coal gasification within economically attainable limits. It is lucky for us that the spearhead of that technology has come to rest in the Netherlands. Shell, Esso and the Gasunie are entering the fray, each with its own technical variation. It is remarkable that each of this threesome has a completely different idea of the end product that is to come out of the gasification plant.

As early as 1913, the German, Bergius, reported that lignite was subject to transformation into a liquid through chemical decomposition under the addition of hydrogen. In this first experiment, the result was a heavy and highly impure crude oil.

In later years the Bergius principle was expanded somewhat and came to be accompanied technically by gasification and later liquefaction following the Fischer-Tropsch system. Before day and night bombing finally reduced the installations, Nazi Germany produced, on an annual basis, a peak of about 4.5 million tons of motor fuel using both techniques. A total of 21 factories transformed coal into gasoline, diesel oil and aviation fuel. The streams of ridiculously cheap oil that flooded American and Western Europe after the war put an end to any further interest in gasification

or liquefaction of coal. The only exception was South Africa, where since 1955 a relatively small plant has been transforming coal into gasoline, diesel oil and raw materials for the chemical industry. The proven Fischer-Tropsch and Lurgi systems, in which gas is first produced and then transformed into liquid fuels, were chosen.

The 1950's and 1960's passed without even the slightest attention being paid to coal gasification. It was the time when oil cost about $1.80 per barrel and the "greenback" was still truly synonymous with buying power and prosperity, but the energetically equivalent product of a coal gasification plant was sure to cost 10 times the price of oil.

The price shock of 1973 and 1974 made little real difference there. Oil did become much more expensive, but the wildly galloping world inflation made coal gasification comparably more expensive. Anyone at that time who asked people in the world of oil how expensive gasoline from coal would be got the standard answer: "At least $5.00 more expensive than tomorrow's oil price."

Even at the current energy prices, coal gasification, let alone liquefaction, is an unprofitable undertaking. That one product is being announced after another now is only due to the assumption that oil will become much more expensive and to the absolute certainty that the oil reserves are limited in extent while production quantities are being determined politically and no longer have any relation to the demand potential of a free market.

Sasol

The aspect of self-sufficiency stimulated South Africa, once again, no longer to leave everything to Sasol I. The first oil flowed from the mammoth Sasol II in March of 1980. In the meantime, Sasol III is fully under construction. Driven by Arab threats, South Africa chose speed rather than new technology. Of all the (coal) energy put into Sasol II, 40 percent comes back out in the form of gasoline and oil. In the laboratory, in the meantime, new techniques have reached 52 percent. For the sake of comparison with the coming Dutch installations, the South African achievements are: In 36 coupled reactors, Sasol II processes 28,000 tons of coal per day for transformation into oil products. In addition, 12,000 tons of coal per day are used to produce energy to run the system. When Sasol III enters full production in 5 years, South Africa will produce 4.5 million tons of motor fuels annually, which is just as much as Germany attained during the war.

Impressive

Judged on a technical and organizational basis, the German achievements were very impressive at the time. That leaves them with the advantage that it is now German firms which can sell expertise in coal gasification. One of them is Lurgi of Frankfurt am Main.

In the Netherlands, it is Gasunie that wants to begin working with the Lurgi gasification system. The object here is to produce medium-calory coal gas that can then be mixed with high-calory natural gas to obtain natural gas with the same caloric value as the gas that comes out of the Groningen dome.

Gasunie has not yet reached an official decision, but according to current plans, in 1985 a gasification plant will be in operation in Eemshaven that will consume 2.5 million tons of coal annually. That is about 7,500 daily. At that quantity, 300,000 cubic meters of coal gas would be produced hourly. Converted into cubic meters of natural gas--over 1 billion--a plant like that would cover about 2.5 percent of the total domestic natural gas consumption.

Burners

In the coming years, more and more high-calory natural gas--around 10,000 kcal per cubic meter as compared to 8,400 kcal Groningen gas--will become available to Gasunie. Because the burners of gas appliances, unless they are specifically designed for high-calory gas, are set for the quality of the Groningen gas, from the middle of the 1980's Gasunie will be in a position where it has a surplus of this high-calory gas (deriving in part from the North Sea, from imports from Norway, Algeria, Nigeria and perhaps the USSR). Through the admixture of low-calory coal gas, a product ultimately comes out of the pipe for which the burners do not have to be changed.

According to Gasunie's technical affairs director, A. W. Guinee, the coal gasification project is "not a thing we will really make a profit on." Still, at least on the basis of current investment costs--estimated at around 1 billion guilders--and at the current coal prices, Guinee predicts that the resulting price will be such that it will even be interesting to add extra coal gas--enriched by washing out carbon dioxide--to the somewhat "less hot" Groningen natural gas to bring that to the lower limit of what is acceptable to the current burners.

For the installation at Eemshaven, Gasunie is being guided by the data provided by the South African Sasol project. At first, an installation with an annual capacity of 1.5 million tons of coal was planned. From Sasol and Lurgi it was learned that 2.5 million tons can be spoken of as an indicated efficient factory size.

According to Guinee and his colleague Dr P. M. J. Wolfs, a factory for 2.5 million tons of coal will almost certainly not be the end of it. There are plans to reserve an area in which three coal gasification plants can be built adjacent to the area where it is proposed that a maximum of four storage tanks be established for liquid natural gas.

According to views of the future which are not yet more precisely defined, two gasification plants would produce gas for admixture to natural gas,

while the third unit would be able to produce gas for delivery to industry, which can be taken to include the natural gas center in Eemshaven.

Gasunie has knowingly chosen to produce coal gas and not to produce natural gas. According to Guinee and Wolfs, the conversion of coal gas, which consists primarily of hydrogen and carbon monoxide, into methane is a step which--given current technology--is sure to be 20 percent more expensive.

It is all the more remarkable, then, that Esso is in fact proceeding to produce methane from coal near the company's chemical plant at Rozenburg. Also different from Gasunie's plans, which call for a commercial factory as far as size is concerned, is the fact that at Esso it is still an experimental plant. "A preliminary stage for commercial plants which should be in operation in the 1990's," according to F.C.R.M. Smits, project coordinator for catalytic coal gasification for Esso Europe. Viewed internationally, Exxon is running a little behind in coal technology. They expect to catch up by aiming for the development of a completely new technology, while almost all the competition is working with refining older principles.

Esso's "great leap forward" is expressed in the gigantic figure mentioned in the press for the Rozenburg experimental plant, that is, 1 billion guilders for an installation where at most 100 tons of coal are to be processed daily. Probably in order to make an impression--the news was released at the time when the Second Chamber was exerting pressure on Esso and Shell to invest their gas profits within the Netherlands--Esso simply hastily added up all that was available.

On further inquiry, the billion guilders proved to consist of the costs of research and development (which is largely carried out in the United States), design and construction (also expenditures which will take place to an important extent outside of the Netherlands) and in running the installation for 3 years of trial operation, for which Esso is assuming that the proceeds will be nil. In fact, the natural gas produced will be used in the adjacent Esso chemical plant. Thus the expenditure of 1 billion guilders comes to be seen in an appreciably less inflated light.

In Esso's philosophy, the decision to produce [synthetic] natural gas is the logical result of two considerations: the first is that the market for medium-calory coal gas is limited, and the second is that it is not reasonable to produce gasoline from coal in Europe because by means of rebuilding existing refinery complexes it is possible to obtain much more gasoline from a barrel of crude oil than is now being done.

In America the refining industry obtains at least four times as much gasoline from a barrel of crude oil as the European average; in Europe there is still a lot of fuel oil being produced. Esso is also setting the example in Rotterdam by building a new "flexicooker" intended to raise the quantity of gasoline produced.

Hard To Tell

According to coordinator Smits the project is not yet at a stage where statements can be made about the final price for a cubic meter of natural gas produced by coal gasification. "But naturally we expect the price to be competitive shortly with the then current oil and gas prices. It is hard to tell now, though."

British Petroleum has no plans to begin gasifying coal in the Netherlands. That is planned, though, in the Federal Republic, through the subsidiary Deutsche BP. In a recent publication, BP arrived at a price per cubic meter of synthetic natural gas of around 35 to 40 [Dutch] cents, which means that in 5 years time, synthetic natural gas will certainly be competitive.

Ultimately Esso is thinking much further ahead than the experimental project in Rozenburg. According to Smits, a commercial coal gasification project means a unit consuming 20,000 tons of coal daily and producing 8.5 million cubic meters of natural gas of 9,500 kcal with it. Calculated on the basis of the domestic annual consumption, a plant like that would cover 7 to 8 percent of the current Dutch gas consumption.

Engineer Smits: "But we are not looking specifically at the Netherlands. It cannot be said that now that we are building the experimental plant in the Netherlands, the commercial plant will also be put here." Then again, that statement is hard to fit in with the answer Esso gave Minister Van Aardenne, when he asked Shell and Esso about their investment plans for the 1980's. Van Aardenne later told the Second Chamber that Esso "possibly" would undertake investments in the amount of 14 billion guilders. However much Esso does not want it said, that figure certainly includes a catalytic coal gasification installation with an annual capacity of about 6.5 million tons of coal.

As early as 1972, long before the October war in the Middle East which formed the overture for the big energy price increase, the decision was reached at Shell that a study of coal gasification must be started. In 1976, the first experimental plant was ready in Amsterdam, and for the past year and a half a larger experimental plant where 150 tons of coal can be gasified daily has been running in Hamburg. The end product is burned off.

Biggest

Project number 3 that Shell is setting up is an installation at Moerdijk, where 1,000 tons of coal will be processed daily. If current negotiations are successful, the gas will be delivered to the PNEM electricity corporation, which will be able to generate a capacity of 125 megawatts with it. Dr J. P. Klein, the man who is studying the development and applications of coal gasification internationally for Shell, says: "You cannot say that this is already a commercial project, but at 1,000 tons of coal it

is about to be the biggest gasification unit in the world. Sasol II processes 28,000 tons per day, but that is done with 36 coupled reactors."

According to Klein, Shell is steadily taking short steps towards the final goal: a commercial installation of at least 20,000 tons of coal daily.

"But by and by it may just as well prove that the economically optimal size is, for example, 40,000 tons," according to Klein. Among other things, that means 13 million tons of coal annually.

Dr Klein: "Shell has always thought primarily of producing gasoline from coal. That intention is still very much alive today."

With an eye to "spreading the risk," as they put it at Shell, an experimental coal gasification plant will probably also be built in the Federal Republic of Germany. It is intended that this unit, also 1,000 tons of coal daily, will be ready in 1985, 1 year after the factory in 'oerdijk. This factory to be built by Deutsche Shell will be used for further studies in the direction of transforming coal gas into liquid fuels.

According to Klein, it need not necessarily be so that Shell will only aim at liquefaction. He also foresees the building of a big gasification installation "to which all kinds of things can be attached," as he puts it. That can be: an electric powerplant, industries that use gas for fuel, a refinery for synthetic transportation fuels and chemical factories that use the gas as a raw material.

When the technique developed by Shell, a ton of coal produces 250 kilograms of gasoline, or 320 liters. A plant with a capacity of 20,000 tons of coal per day produces approximately 2 billion liters of gasoline or diesel oil annually at a running time of about 320 days per year. That is an extremely extensive contribution, for last year the Dutch consumption of gasoline and diesel fuel for road transportation was 8.2 billion liters.

Government

Just like Esso, Shell, too, is making no statement about where the definitive commercial gasification plant will go. In any case it need not automatically be put where the cheapest coal can be had. Klein: "I think that in the future the local conditions--the governmental policy--will be more important than the source of the coal."

According to Shell's Klein, coal gasification will become much more prominent in the world. "I have absolutely no doubt that these plants will be built in large numbers. In any case, they have a high priority with us."

At this point, Klein pointed out the fact that in the United States, President Carter has determined that the country must have a daily production

around 1990 of 1.5 billion barrels of synthetic gasoline. In other terms, that means the construction of a mere 40 factories with a daily capacity of 20,000 tons of coal each, at a price of about 4 billion guilders each.

For the rest, at Shell it is not expected that gasoline will be made from coal on a large scale in Europe before 1990. That is more a question of the as yet incomplete command of the technique rather than of price considerations. At current world coal prices and transportation costs, the production of synthetic gasoline already looks economically feasible. Shell's calculations come out to a least projected production cost--compared to production from crude oil--equal to about $38.00 per barrel of crude oil. That is the price that several OPEC countries are now asking. Whether that would, in fact, be the definitive production price may well be questioned, in light of a statement by Dr Klein: "Thus far, everything has become more expensive than we had hoped."

If Shell and Esso were to decide shortly to build a commercial gasification plant here--and the chances of that are particularly good--then they, together with Gasunie, would be good for an annual coal consumption alone of 15.5 million tons around 1990. Furthermore, that would then possibly be only the beginning of an even more extensive gasification effort in the following years, which seems certain as there are yet others in our country (including the communities of Rotterdam and Amsterdam and the gas distribution industry as a whole) who are studying coal gasification projects here at the moment. There is already a scenario at Esso in the Hague which estimates Dutch coal consumption over 20 years to be 40 million tons per year, appreciably more than the Ministry of Economic Affairs' figures which appeared in this spring's Coal Report, which called for 30 million tons.

Environment

The fear of extensive environmental pollution forces its way to the foreground on the hearing of such enormous quantities of coal. The government report mentioned above on future coal consumption states: "The state of the art of coal gasification and liquefaction does not yet permit a precise estimate of all the consequences to the environment."

At the moment the firms that are about to begin working with these techniques in the Netherlands have the benefit of the doubt on their testimony that it is no problem technically to have the processes run clean. Dr Wolfs of Gasunie: "In South Africa, Sasol II is a completely clean installation. The techniques are already known." Shell's Dr Klein: "We find our system to be an absolutely environmentally benign process which produces so little pollution that no one will have any difficulty with it."

The biggest problem with waste processing is the question of what to do with the ash wastes. Depending on the kind of coal used, at least between

12 and 16 percent by volume will be left as ash. In South Africa, 40 percent of the ash is processed as construction materials. Such applications are also planned for the Netherlands, but even then there will be towering mountains of residue, for which a solution must be found.

Another as yet unanswered question is whether there will be enough coal available. And especially, what will the price developments be? The United States has calculated that its exports over the coming 20 years will have to grow from 5 million tons of coal now to 100 million tons. The coal reserves are abundant, the only question is whether the infrastructure can be developed in time. New mines, new railroads and new harbors are needed. Particularly in America, resuming the throne of "Old King Coal" will involve enormous investments, for along with the investments for coal export, the country is betting increasingly heavily on coal for its own domestic consumption.

Engineers

For the Netherlands, where to a large extent the technology of coal gasification will take form, quite another problem is looming. Shell's Dr Klein: "It may very well happen shortly that there will be no lack of money or of coal but of people. I foresee a great demand for chemical engineers and you cannot get the men and women. It was said a few years ago that there would not be any more future in that field and the result has been an enormous decline in the number of students who chose that discipline. Just say that we will quickly have more need for chemical engineers and perhaps a bit less for all manner of -ographers and -ogians."

And his colleague, Esso's Smits: "We are in the middle of a very important scientific development. If the basic interest cannot be aroused at the technical universities, in 10 years we will lack the people who have the knowledge to be able to build up coal technology."

6940
CSO: 3102

SYNTHETIC FUELS FROM COAL: PROGRAMS, PLANTS

Rome NOTIZIARIO COMITATO NAZIONALE PER L'ENERGIA NUCLEARE in Italian May 80
pp 74, 75, 77-80, 83-85

[Excerpts] Liquefaction

Japan--Following the oil crisis of 1973, the Agency for Industrial Technologies (ATI) of the MITI [Ministry of International Trade and Industry] launched, in April 1974, the Sunshine program, divided into five research groups: solar energy, geothermal energy, new uses of coal, development of hydrogen as an energy-carrier, as well as a number of less important lines of research that could nonetheless lead to future developments.

As regards the new uses of coal, the work undertaken within the framework of the program mentioned relates essentially to the methods of liquefaction and gasification.

There are three methods of liquefaction that are under study and should be tried out in pilot units between now and 1981: the direct-liquefaction method, the solvent method and the solvolysis method.

As regards the first method, the Government Industrial Development Laboratory of Hokkaido (ATI) is doing basic studies along the lines of analysis of the chemical structure of coal; basic research on the liquefaction reaction; secondary treatment of the primary-reaction products; research on the use of a continuous reactor.

The University of Yamagata on the island of Honshu has designed a 2.4 tons-per-day tubular-type reactor, construction of which, assigned to Mitsui Ship Building Engineering, should begin in 1980. As the result of an agreement signed in September 1978, the method should soon be the subject of Japanese-United States collaboration.

The National Institute for Research on Pollution and Resources has had the assignment of studying the solvent method. Although the studies are not completed, a continuous-pouring system with a capacity of 1 ton per day has been designed, and construction of it--by Sumitomo Metal--was to begin at the end of 1979.

Table 1. Plants for Liquefaction of Coal

Country	Site	Capacity	Date (or planned date) of Start of Operation	Method Used	Companies or Programs Involved
Great Britain	Point of Ayr (Wales)	25 tons of coal per day	mid-1983	extraction with liquid solvent	NCB, Energy Dept
	Point of Ayr (Wales)	25 tons of coal per day	mid-1983	extraction with super-critical gas	NCB, Energy Dept
FRG	Bottrup (Ruhr)	200 tons of coal per day	1980-1981		Ruhrkohle AG Veba Oel AG
	Voelklingen (Saarland)	6 tons of coal per day	1980		Saarbergwerke

As regards the third method, Mitsubishi Heavy Industries built in 1977 the major part of a 1 ton-per-day unit with the aid of the Electric Power Development Co, Ltd, and of the ATI.

The tests ended in March 1978, and there have not been any great difficulties.

In addition, the National Industrial Research Institute of Kyushu (ATI) is doing comparative studies on the systems that use the solvolysis method as well as on the related procedures such as desulfuration of products by means of $AlCl_3$ or separation of residues.

The next phase regards the construction, in 1980, of a 40 tons-per-day unit.

Apart from the Sunshine program, we should mention the important collaboration action between the United States and the FRG for the construction, in Morgantown in the United States, of a 6,000 tons-of-coal-per-day plant in which the SRC [expansion unknown]-II method, already mentioned, will be used.

Japan will have a 25-percent participation in the cost of the plant, which is estimated at $700 million.

In addition, a consortium of national companies--KOMINIC, formed of Kobe Steel, Mitsubishi Chemical, and Misho Iwai--has made an agreement with the South African company SASOL [South African Coal, Oil and Gas Corporation] for the development of alternative liquefaction methods, of which we shall speak below.

Great Britain--With the financial support of the EEC, two methods for hydrogenation of coal have been studied.

One is being used for extraction of a liquid solvent yielding hydrogen derived from the process. It will dissolve coal at a temperature of 400° C, and after filtration, the solution will hydrogenate. The products are benzene, kerosene, and solvent that will go back into circulation to dissolve more coal.

However, it does not require either catalyst or molecular hydrogen. The other uses supercritical gases as solvents. This technique was applied to coal for the first time at the beginning of the 1970's. In 1977, a unit went into operation that yields 0.1 ton of coal per day for development of the method.

Low-boiling-point organic solvents, especially lower aromatic hydrocarbons, have been used as supercritical gases.

Construction of two pilot plants of 25 tons of coal per day, which will be built near the Point of Ayr mine in north Wales and in which both methods will be tested, was recently decided on.

For construction of them, the National Coal Board (NCB) and the Department of Energy signed in February 1979 an agreement for a 50-50 financial contribution.

In April of the same year, Matthew Hall, Ltd, was assigned the consultant work for the project, including the costs also; this work was to be completed in Spring 1980.

The tenders will be prepared, presented and examined between Spring and Autumn of the same year.

The time required for the project--supplying of materials and construction--can be estimated at around the end of 1982. Toward the middle of that year, the plants should start functioning, while the experimental operations should start about the middle of 1983.

According to the estimates, the two pilot plants should produce about 10 tons per day of liquid products similar to those produced by an oil refinery.

Construction of commercial-scale plants for production of petroleum, jet fuel and diesel oil, and materials for the chemical industry is expected in the 1990's.

Federal Republic of Germany--The research and development work on liquefaction of coal is being carried out under the auspices of the government, in various private institutes, universities and industries.

The FRG has signed an agreement with the United States regarding the experience that will be acquired from operation of a plant with capacity of at least 5 tons of coal per day.

Bergbau Forschung of Essen has obtained a contract for study of direct liquefaction of coal.

Since the end of the 1950's, it has been conducting basic research that has led to the design and construction of a unit of 0.25-0.5 ton of coal per day. This unit will test the possibilities of producing medium and heavy oils.

At the end of May 1979, the construction work on a plant to produce petroleum from fossil coal was started by Ruhrkohle AG and Veba Oel AG at Bottrop, in the Ruhr. The investment costs for the plant are estimated at about 280 million DM, and the two companies are participating in the ratio of 60 percent and 40 percent, respectively, along with the government of the Land of North-Rhine-Westphalia, which is contributing DM 129 million.

The plant, which should start operating in 1980-81, has been designed on a semi-industrial scale for a capacity of 200 tons of coal per day, from which 18 tons per day of liquefied petroleum gas, 29 tons per day of light oil and 69 tons per day of medium-weight oil will be derived.

These crude products will be processed in the Veba refinery of Scholven, to obtain commercial products such as: fuel oil, diesel fuel, gasoline, and raw materials for petrochemistry.

Furthermore, Saarbergwerke of Saarbruecken is building, at Voelklingen in the Saarland, a pilot installation of 6 tons of coal per day, which is expected to go into operation in 1980.

The FRG is also participating with Japan in the building of the plant, mentioned above, in Morgantown in the United States.

Gasification

Belgium--If a joint Belgian-FRG project relative to underground gasification of coal at a depth of more than 800 m, which is to begin at the end of 1981, turns out favorably, it could open the door to the use of sizable resources of unused coal.

According to the most recent geological evaluations, such resources are estimated at several billion tons, but they are at a depth between 1,200 and 5,000 meters.

Apart from the depth at which the coal is located, the project is of interest on account of the unusually high pressure--25 to 50 atmospheres--at which the gas is obtained.

Table II. Plants for Gasification of Coal

Country	Site	Capacity	Date (or planned date) of Start of Operation	Method Used	Companies or Programs Involved
Belgium	Mons	--	--	subterranean gasses	Joint Belgian-FRG project
Japan	--	7,000 m^3 per day of gas of high heating power	--	--	Sunshine project
	--	50,000 m^3 per day	--	--	Sunshine project
	Hokkaido	40 tons of coal per day	1974	--	Sunshine project
	Hokkaido	250 tons of coal per day (?)	1985	--	
The Netherlands	Amsterdam	6 tons per day	1976	--	Dutch Shell
	Hamburg	150 tons per day	1979	Shell-Koppers	Dutch Shell
	Moerdijk	5,000-6,000 tons per day	end of 1980's	--	Dutch Shell electric power company of northern Brabant

It appears that apart from the Soviet Union, a plant of this kind on a commercial scale--notwithstanding the numerous pilot-scale experiments--has not been built anywhere in the world.

The project, which will take 6 years, will cost about $41 million, 40 percent of which will be furnished by the Commission of the EEC, and the remainder by Belgium and the FRG.

The site selected is near Mons, in Belgium, in an unworked coal mine.

It is proposed to do the gasification in two separate coal levels, at 860 and 960 meters.

It would be interesting to succeed in demonstrating the possibility of obtaining two gaseous currents: one of gas of low heating power, to be burned in electric-power plants, and the other of gas of medium heating power, as a raw material for the chemical industry.

This objective would be extremely attractive to all the countries of the EEC that are dependent on foreign energy sources and are subject to the high cost of the coal produced by the conventional methods.

According to the project director, the considerable depth at which the coal is found offers three big advantages for underground gasification: the absence of water, the impermeability of the rocks, and the capacity of the rocks to tolerate very high pressure.

France--After 1976, two economic-interest groups were set up in this country.

One is the GEGS (Subterranean Gasification Studies Group), for underground gasification of coal, and the other is the GEGN (Gasification of Coal by Nuclear Heat Studies Group).

The former was established by Les Charbonnages de France, Gaz de France, and the French Petroleum Institute; the latter is composed of the same groups and also the CEA [Atomic Energy Commission], Creusot-Loire and Novatome.

It should be pointed out that the funds made available to the GEGS are rather limited--30 million francs for 4 years, a good part of it (40 percent) being furnished by the EEC.

Japan--Within the framework of the Sunshine program mentioned above, the work relating to gasification methods concerns the obtaining of gases of high and low heating power and production of gas by the plasma method.

In 1978, construction of a pilot unit of 7,0000 m^3 per day for production of gas with high heating power was started. After 2 years of operation, this unit will be followed by another, of 50,000 m^3 per day. The industrial target is 1 million m^3 per day, and it has been set for 1990. As regards production of gas of low heating power, the Mines and Coal Research Center is conducting a program of measurements on the 5 tons-per-day unit built in 1975. In parallel with these tests, construction of a 40 tons-per-day unit, operation of which was to begin in 1979, was started in Hokkaido in 1978. The following phase will be the construction of a 25 tons-per-day unit combined with a cycle generator, construction of which should begin in 1982, while the experiments should start in 1985.

As regards production of gas by the plasma method, the research assigned to the National Institute for Research on Pollution on Resources of the ATI began in 1976. For the time being, they are limited to basic studies, to be followed in 1981 by the feasibility and practical construction studies.

The Netherlands--Dutch Shell has announced plans for construction, by December 1983, of a gasification plant with capacity of 1,000 tons of coal per day. It will furnish gas, for production of electrical energy, in a combined-cycle plant with steam turbines and gas turbines.

If the plant succeeds, Shell plans to build a commercial gasification plant of 5,000-6,000 tons per day at the end of the 1980's.

The site planned for the installation is Moerdijk in southern Holland.

It is reported that the provincial electric-power company of northern Brabant intends to buy the gas produced from the coal, in accordance with agreements to be established, both for the Geertruidenberg power plant and for the Moerdijk industrial complex.

Shell and the electric-power company should come to a final decision on the investments by the end of 1980.

The plant would follow a 6 tons-per-day pilot unit that started operating in Shell's Amsterdam laboratory in 1976 and the 150 tons-per-day demonstration plant that officially went into operation in Hamburg in 1979.

The plant, which uses the Shell-Koppers system, that makes it possible to produce high-quality water gas, will operate until 1983.

The objectives to be reached during this period are, among other things, increasing '' pressure in the gas-production unit from the present 25 bars to a maximum o '00 bars, which would make it possible to obtain a higher percentage of methane as well as adapt the plant to the type of gas to be produced (city gas, natural or synthetic gas).

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RESEARCH POLICIES REVIEWED

Problems, Plans

Paris LE NOUVEL ECONOMISTE in French 16 Jun 80 pp 28-35

[Article by Jacqueline Giraud: "How to Save Research"]

[Text] By neglecting its scientific-research policy for 12 years, France has sacrificed one of its best advantages. The government and the industrialists now say they are determined to catch up. It is first and foremost a problem of means. But research is also suffering from the blockages and scleroses inherent in French society.

"In the Olympic Games of research, only the gold medals count." On 29 May, speaking before Parliament, Pierre Aigrain, secretary of state for research, affirmed the necessity to "make French research one of the very best in the world." In the name of the industrialists, Roger Fauroux, head of Saint-Gobain-Pont-a-Mousson, declares that the companies are ready to furnish half of the effort--on condition that the increase in their research and development expenditures will be compensated for by tax relief.

Although France, with the CNRS [National Center for Scientific Research], has the world's biggest research organization, and although it is spending some 48 billion frances this year in the public and private sectors, employing 68,000 scientists, it has a serious handicap to overcome. As the 1980's dawn, the challenge is no longer from America only; in the sectors of the future, electronics or the biotechnologies, it now comes from Japan. Whereas that country had the image of a "pirate" of technologies, in the last 10 years it has made a fantastic effort to provide itself with independent research. In 4 years, from 1971 to 1975, it created 61,000 researcher positions; per capita, it now has twice as many as France, and in absolute terms, four times as many. At the end of the 1960's, France, on the contrary, like the other Western countries with the exception of the FRG, seriously slowed down its expenditures on research.

The breakoff occurred in 1968, when after 10 years of Gaullism, with an average budget growth of 15 percent per year, a solid research potential was built, provided with new equipment and battalions of zealous young recruits. A little too young, and a little too involved in the great revolt of the

universities. When Georges Pompidou became president of the republic, he was not to pardon them. The lean years began. In France as in the United States, they were prolonged under the effect of the disputing of science, the crisis of confidence in the benefits of progress and technology. The record year was 1975, when research expenditures increased only 0.5 percent! They were victims of the economic crisis, to be sure, but precisely this crisis should have led to the encouragement of science, if it is true that "grey matter" is the best card in France's hand in the new world economic competition.

Distribution of French Researchers

Public organisms (including 8,700 in the CNRS)	24,500
Academics (part-time researchers)	40,000
Companies	34,000
Nonprofit institutions	1,500
	100,000*

* That is, 68,000 full-time researchers, keeping it in mind that the 40,000 academics are only part-time researchers.

In 1975, two inner-cabinet meetings in the Elysee decided that the lost time had to be made up. Their main effect was to check the regression. It has been only since a year ago, after a new cabinet meeting in the Elysee, that French research has been in a position of honor. Or rather, in the dock. For even though it has promised to catch up with the FRG's financial effort, the government has first undertaken to reform the structures of research so as to "increase their effectiveness." Changeover of the mission of the CNEXO [National Center for Exploitation of the Oceans], breakup of the IRIA [expansion unknown], an audit committee for the INRA [National Institute of Agronomic Research], reform of the CNRS, transformation of budgetary procedures, new regulations for researchers: after suffering neglect, the scientists are overwhelmed by such an excess of interest!

But isn't it too late to make up for the time lost? "We have a good research apparatus, with enormous holes in it," considers Dr Jacques Benveniste, of the INSERM [National Institute of Health and Medical Research]. "It is like the filling of a dam. Up to 1968, the water was rising well, and the way it was going, it would have overflowed about 1975. The faucets were turned off too soon for the irrigation!" As for the United States, it suffered less from the application of the brakes because there, the "dam" had been "overflowing" for years. Last year, the DGRST [General Delegation for Scientific and Technical Research] drew up a first report on "the state of French science and technology." Strong points: mathematics, genetics, nuclear and atomic physics, fluid mechanics, geophysics, space research,

computer software, etc. Weak points: materials science, many sectors of chemistry, immunology, bacteriology, nutrition, weather research, etc. One of the participants in this exercise stresses its limits: "In a sector that is mediocre on the whole, there may be one or two leading researchers. This is the case in electrochemistry. What judgment can we make? In genetics, we have several teams in the top world rankings, but not enough trained young researchers to exploit our advantage, while the Americans are turning out lots of them.

"We understand the present situation and we do not want to be greedy," says Dr Claude Kordon, neuroendocrinologist with INSERM and member of the scientific committee of the CNRS. "But with credits stagnant while salaries are rising, the operating credits per researcher have dropped 34 percent in 8 years. In the life sciences, the personnel costs represent 79 percent of the budget. We have good researchers but not the means for them to work with. The young research candidates are better than 10 years ago, but we cannot recruit them. In all fields, we are at the end of our tether." "Overall, our potential has not deteriorated yet," considers Andre Danzin, French president of the European Research and Development Committee. "The FRG, which it is desired to catch up with, is less superior to us than is believed. It is stronger in the sectors connected with its traditional industries: chemistry, pharmacy, precision mechanics and heavy machinery. And it has been more successful with the university-industry connection. For the future, its position is not better, overall, than ours. It is just as deficient in biotechnology and less advanced in space, electronics and software. The real danger comes from the Pacific, from California and at the same time from Japan, both of which have known how to detect the rising currents of research: the information technologies and the life sciences."

As for these "rising currents," what prevents French science from going with them now? Is there any other impediment than the insufficiency of credits? Whether they are described in their "easy chairs" or in their "ivory tower," scientists have a poor brand image. "An outmoded image," considers Robert Chabbal, the preceding director of the CNRS. "Especially among the young, there is a healthy eagerness to know what will be most useful. In many committees of the CNRS, there is no longer any discussion of the principle of having contacts with the socioeconomic world, but rather about the manner of achieving them." From the basic researcher to the industrialists and the political authorities, everyone is in overall agreement about the principal evils that affect our research system: the aging and nonmobility of researchers, unequal effectiveness, and especially, the poor transfer of discoveries downstream. What the researchers are not all convinced of is the idea that the new decrees and organization charts are suitable remedies.

The new regulations for researchers provide for two mobility "obligations," at the beginning and in the middle of one's career. Prof Pierre Chambon, who directs at Strasbourg one of the best teams in genetic engineering, remarked when he received the gold medal of the CNRS: "All my collaborators are or have been research attaches with me. What sense would it make to dismantle my team?" Remarks Philippe Chartier, department chief of the INRA

and member of the research committee for the Plan: "Depending on the field, researchers become creative after 7 to 15 years of research. Therefore, mobility should not be imposed on the young, but rather later. And in order for it not to be synonymous with stress, insecurity, it should be conceived of within an overall policy of scientific employment." This opinion is shared by Pierre Laffitte, director of the School of Mines of Paris, who chairs the Plan research committee. Recently, he made quite a disturbance by a somewhat provocative note suggesting the elimination of "full time" and the creation of a competitive research market." "I was not referring to the CNRS, which has an exclusively research function and fundamental purpose. It is normal that its researchers are full-time. But they represent only 10 percent of the national force. What I am suggesting is a scientific-employment policy which covers a whole range of functions in research, administration, industry, a whole range of jobs that the same person could do successively at different stages in his life. But to promote mobility, it must not be decreed; rather, what impedes it should be eliminated."

In this regard as in others, research suffers less from specific illnesses that from the classic blocks and scleroses inherent in French society. Take the example of an academic from the University of Grenoble detached to work at the Laue-Langevin Institute--the high-neutron-flux reactor located in Grenoble: he will be forbidden to participate in the university's sports activities or to eat in the cafeteria!

Bureaucracy: because two of its researchers are going off to a company on "mobility," the director of the Higher Normal School has to spend a whole day at the ministry to get their files in order. Many researchers have spouses in teaching; nothing is done to harmonize the mobility of one with the assignment of the other. A researcher of Bordeaux wants to go the United States for a year, and his wife, a technician in research, asks for a year of leave without pay. The reply: you will not find your job when you get back. Thus, the mobility so vaunted is neither favored nor productive. An extreme case is medicine: under the feudal guardianship of the "heads," success in internship and the further "career plan" imply the immobility of the boat.

As a corollary of the injury of nonmobility, the researcher is the butt of the general suspicion that hangs over the public sector: do people really work in these big organisms? How is one to judge, and who sanctions, the work of a researcher? Aren't entire laboratories sleeping through lines of interest that hold no interest? It is true--it is a French sickness--that the natural tendency of the organisms is to grow, and that what has been created is rarely eliminated. Mr Danzin deplores this "Colbertist tradition." "If the CNRS did not exist, multicenter systems would be better. But it does exist, and the French are attached to their big organisms. Therefore they have to be made to function as they are, with the maximum responsibility restored to the rank and file." The recent reform of the CNRS sanctions an evolution that has largely occurred in reality already: decentralization and opening-up to the outside world (see final section).

There remains the major problem for the effectiveness of research: evaluation of people and projects. All countries have this problem; a lot of ink has flowed on the subject, and it has given rise to various experiments. The researchers of Bell, for example, are subjected every year to the verdict of an international jury which grades them from 1 to 150; the lowest are terminated. In the CNRS, the procedure is not so pitiless. But while they rarely dismiss anyone, the scientific officials of the CNRS devote a lot of time to judging people and programs. "This judgment by peers does not signify judgment by colleagues, with what that could imply of clan spirit," Chabbal stresses. "There are objective criteria. Another very fundamental consideration is that successful research has 'users': other researchers. The number of publications, citation by peers, presence at the international conferences: these are operational criteria." Can one scientist have the heart to "terminate" another? The means of action are more "deterrent." "When a laboratory is working poorly, it is often a problem of scientific management," most officials consider. To save the team, the head has to be changed. Out of reticence, no names are mentioned, but there are several examples of laboratory directors who, while retaining their salary and status, have been relieved of thier functions. The CNRS can also withdraw the label of "associated laboratory"--as well as the credits and positions that go with it--from university laboratories that enjoy it (30 percent of them). The problem remains of the other university laboratories, whose activity, it is admitted, is often very "academic." Compartmentation and rigidity: here, research suffers from the ills of the university.

"In the CNRS, the scientific hierarchy has become very attentive to keeping a laboratory from going to sleep on a line of research," Chabbal considers. "The researchers now know that they have to change subjects in order to be favorably judged, that 'mobility' on research lines is the counterpart of the status of 'professional researcher.' The inverse risk is arrived at: the very good laboratories, the very good researchers, do not want to stay on a subject that is not of the very first order. Thus it is that microbiology has been too much abandoned in favor of molecular biology." An impediment to "mobility" on lines of research is the fact that in order to take up a new subject, new equipment is often needed. "In the best of cases, it will take me a year to obtain a new apparatus," says Dr Benveniste. "Meanwhile, I might perhaps have borrowed one from another laboratory, or my hypotheses may have changed. It is impossible to cancel the order or change it! What is more, we suffer from the nonexistence of a solid scientific-apparatus industry. Too many good instruments come from the United States--which enables the American researchers to do certain experiments 4 years ahead of us."

Dr Benveniste, feisty and ebullient, has nonetheless known how to "finagle." Specializing in allergology research, he was working in the United States in 1971 when he discovered the PAF (platelet activating factor), a substance secreted by the organism that aggregates the blood platelets. Aggregation of platelets--a function that goes beyond the domain of allergology--is the mechanism that forms clots and causes thromboses. Back in France, Dr Benveniste tried to learn the molecular structure of the PAF. He needed hun-

dreds of liters of blood in order to isolate a very tiny fraction. Rhone-Poulenc furnished the blood; the Institute of the Chemistry of Natural Substances of the CNRS began to decipher the structure of the molecule and made a partial synthesis of it last October. The work of Texas researchers was hard on the heels of the French team. A new actor came on the scene: Prof Jean-Jacques Godfroid, who works regularly with Specia and who obtained some credits from it; he achieved the complete synthesis of the molecule in February, in his laboratory at the University of Jussieu.

There are two lessons to be drawn from this fine adventure. First of all, only private financing offers the flexibility and speed that make it possible to avoid being "left at the post." Secondly, the result of research is rarely what one expected of it: Dr Benveniste, an allergologist, made a discovery that can lead to a new treatment for cardiovascular diseases. This example throws light on the refusal of researchers to be "dragged along by the current." Not that they do not want to be useful. But they know that the pathways of research cannot be adjusted to goals that are defined too precisely at the outset.

"We should do away with the false distinction between the fundamental and the applied, a distinction that is based solely on motivation and ignores working method and the nature of the results," Prof Chabbal explains. "There are 'root sciences,' whose motivation is to push the roots of knowledge deeper, and in the process, there is unforeseen 'fallout.' And there are transfer sciences--the tree trunk--that are carried on in public organisms and in industry and whose purpose is to feed the sap toward the applications. But in the course of this work, a lot of basic research is done too." There is the case of "information theory," born in the Bell laboratories, even though its author, Claude Shannon, was aiming at applications in the electronic communication systems. But although the French researchers of the public sector have long mistrusted applications," today it is the industrialists who do not always understand why their laboratories are led to do basic research. In order to do "downstream transfers" successfully, it is not enough to "branch" two containers--public research and the industrial laboratories--to make them communicate. In reality, in order to go, for example, from work in solid physics to an application in electronics, a cascade of steps has to be crossed, half of them in the CNRS and half in industry. If only one step is missing, or if there is no common language or "translator" between two steps that is enough for the "sap" not to pass.

Joel de Rosnay, director of research applications in the Pasteur Institute, thinks that procedures have to be created which take the researcher's motivations into account. "It is not his work to develop the applications of his discoveries. Inversely, it is necessary for him to be able to follow their development, to be associated in the decisions, to have dialog with high-level industrial researchers. He also has to be compensated for the time he devotes to this: credits or equipment that will aid his laboratory, and sometimes a personal remuneration."

At the Pasteur Institute, the development process goes through three phases. A committee composed of 15 researchers, that advises on the Institute's ap-

plications examines every 2 months the new ideas that merit a feasibility study; a flexible procedure enables the Department of Applications to make the necessary credits available rapidly. Then, in the Research Applications Council, the officials of the Institute and the representatives of Pasteur Production decide together on the projects that deserve to be pursued. Finally, there are also scientists on the board of directors of the development center that chooses the products that will actually be made.

At Orsay, Jean Camplan worked in a very fundamental field: he made "isotope separators" for the work of the atomic physicists. At the beginning, the very designing of these instruments implied research on the mechanisms of separation. "Up to the day when there was nothhing much more to learn about the technique of the separators. Many identical laboratories shut down because they stayed too closed-in on themselves," Camplan recounts. The Orsay laboratory established a reputation by fabricating increasingly sophisticated tools for the French and foreign physicists. Then a subsidiary of Nikon, the Balzers company, asked him to make the plans for an ion implanter, a machine used in the fabrication of integrated circuits. After a prototype was built by a Villejuif firm, the machine is now marketed by Balzers. Camplan, an engineer, was able to handle the "transfer" stages himself: "It came along in the flow of my career, and at a time when I was beginning to get bored," he says. Another case, a more celebrated one, is that of Prof Georges Bret, who left the university to create his own firm making high-precision lasers; with a subsidiary in California, Quantel is today one of the two world leaders in its specialty.

These are exceptional examples. "One should not expect them to multiply," Joel de Rosnay thinks. "In the United States, where the universities are private, like the industries, the two menatlities are close to one another; it is not surprising for scientists to create companies. In France, it is necessary to proceed by stages, for the university to get the attention of the agencies or associations responsible for the transfer of research results, for industry to recruit people trained in the university dialog." "We live in a clan structure," remarks Dr Kordon. "In the United States, academics swarm in all sectors of activity. In France, it is said that the university does not prepare one for active life, but outlets are closed to it. The administration is held by the graduates of the ENA [National School of Administration]. Industry recruits its management staff but also its researchers, from the specialized graduate schools. It is not surprising if the university and public research have some trouble in communicating with the socioeconomic world."

The researchers, accused of disdaining the "downstream" world, turn against it. "For medical research, and even though this is in the process of changing, the pharmaceutical industry has not been a very stimulating downstream sector," remarks Benveniste. "Likewise, we are also suffering from the near-nonexistence of good clinical research." Moreover, the downstream sector is not just industry but the whole of the socioeconomic objectives. The successes of the 1960's were born from the encounter of a political will to modernization and the country's independence with the emergence of a dynamic

scientific community. Oriented by the political objectives, the best results were obtained in the forefront technologies, aerospace and nuclear energy. The difficulty today is that the objectives are implicitly modified without the new ones being clearly defined. The effort put into the advanced sectors--which are not the ones that create the most jobs--has been expended to the detriment of irrigation of the entire industrial fabric by research.

"We are not very convinced o the necessity of research," says Jean-Pierre Causse, director of the Saint-Gobain research group. "In 1975, after the crisis, Roger Martin noted that we had held up in those areas where we simultaneously held a significant part of the market and had mastery of our technologies. For the traditional industries, the problem is that we have trouble financing and developing research. The group devotes 500 million francs to it--1.5 percent of consolidated turnover--almost all of it self-financed. Nevertheless, we have had to abandon the basic research on the structure of glass that we were conducting in the 1960's. This is dangerous, because there is an important theoretical revival regarding the structure of materials. Thus we hope that the CNRS has the means to pursue this fundamental work."

The public researchers, Mr. Causse notes, "hesitate to give to the private sector." "Why should we favor one firm rather than another, and see a multinational given the fruit of work done with the taxpayers' money?" the researchers reply. Here too, university-industry relations suffer from a more general problem: the absence of consensus on clear socioeconomic objectives. "What makes the strength of Japan or of the FRG," Mr Danzin remarks, "is not only the superiority of their financial effort; it is also the existence of a social consensus."

The final difficulty: the size of France does not enable it to do everything or to take the risk of abandoning entire areas of science. Therefore it must maintain a basic-research potential that keeps up "alert activity' in all sectors; but it must also choose the strong points of its scientific development. The effectiveness of French research therefore requires a redefinition of its objectives and its strategy. Definition of objectives: with the new budgetary procedures, the "client" ministries--Industry, Health, Agriculture, Trasnportation--will henceforth be associated in the programming ofthe purpose-directed research, while the secretary of state for research, Pierre Aigrain (see interview below), is putting the final touches on the "10-year research strategy" that he has been working out with the DGRST for several months.

If the researchers remain reserved, it is because in their view, the definition of the objectives and the strategy should have been subjected to broader debate, in the absence of which, there is always a risk of not having a consensus. The majority of researchers today want to come out of their "ivory tower." But they still have to be given the means for doing so.

The Opening-Up of the CNRS

The CNRS exercises supervision over more than 1,400 research laboratories and teams. Of these, only 185 and 170 teams are the CNRS's own units, and they absorb more than half of its budget. The others are "associated" units, in universities, the College de France or other public organisms that have multiyear contracts.

The reform has lightened the central administration to the advantage of deputy administrators in the provinces, of whom there are presently 15. In order to improve the contacts and the tracking of the work of the teams, it has strengthened the scientific directorates.

The opening-up to the outside world is expressed by the presence in its governing body, the Council, of four industrialists, four high-level civil servants, and six scientists who do not belong to the CNRS.

The new management has also decided to create a "dissemination" mission that will organize visits by high-level researchers in industry or in the government to acquaint them better with the potential of the CNRS and to improve transfer.

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Aigrain Interview

Paris LE NOUVEL ECONOMISTE in French 16 Jun 80 pp 29-31

[Interview with Pierre Aigrain, secretary of state for research: "A 10-Year Strategy"; date and place not given]

[Text] [Question] What, concretely, does the decision to catch up with the FRG's financial effort mean? In how many years does this have to be chieved in order for it to be effective?

[Answer] The expenditures on research and development represent roughly 1.8 percent of the GNP of France, as against 2.3 percent in the FRG. It would be unrealistic to hope to close this gap in less than 5 years; and it would be meaningless in more than 10 years. A reasonable objective of 7 years means that the research expenditures must have an annual increase 3.6 percent higher than that of the GNP. On the average, and not necessarily, and not necessarily starting in 1981. The present draft budget seems to fall into this line.

[Question] How should this effort be distributed between the public sector and the private sector, between basic research and purpose-directed research, among personnel expenses, operating expenses and new equipment?

[Answer] It will be impossible to catch up, even in 10 years, if the effort of the companies is not of the same order of magnitude as that of the state. The reaction of the companies is that this will not be done all by itself! Incentives will be needed. In the domain that comes under the state, there are some obstacles. There are strong annual fluctuations in the financing of the big technological programs (which now fall outside the research package). Nevertheless, on the average, it will not be necessary to sacrifice the long-term research to them. Within the "research" package, I think there is now a good balance between purpose-directed research and basic research. The latter has suffered in recent years from the desire to increase the purpose-directed part in budgets that have stagnated. I believe that basic research should no longer be disfavored. The major problem today is the weak condition of the operating means; this category will have priority. New heavy equipment poses a difficult management problem because it makes big "peaks" in the budget. We have just done a study to try to plan these expenditures over a period of time. This exercise is unfortunately running a little late, since because the orders were not staggered better, we will have a large accumulation of expenditures next year.

[Question] WHat level do you think French research is on? Hasn't it suffered irremediably from a 10-year period of lean years?

[Answer] If there were not a boosting of the means of French research now, it would lose ground. But not everything has been negative in recent years. The situation of 1968 entailed a lot of waste; austerity led to better efficiency. And especially, the researchers being recruited now are indisputably better-trained and of better quality than 15 years ago.

Moreover, French research, which represents 6 percent of world research (in proportion to the size of France), is holding its place very honorably. We areleaders in several areas. If we take the criterion of international citations, we note that in several sectors, more than 15 percent of the citations relate to French work, which is far higher than our quantitative weight.

[Question] You want to "force" the researchers into mobility. Do you think they can be mobile in a country where no one is?

[Answer] This is a real problem. The researchers are already more "mobile" than the average for the French people. But nonmobility, which is troublesome in other fields, is catastrophic in research. It causes sclerosis. Among the impediments we must also note the mentality of certain bosses, little mandarins, who do not want to let their young researchers go, especially if they are good. We are not proposing to impose mobility but to facilitate it. An important element--one that is not up to us--will be the development of industrial research and the possibilities that it will offer.

[Question] In this area, isn't the cleavage between the universities and the specialized graduate schools a powerful impediment?

[Answer] This split has played a very unfavorable role for the French economy. It has effectively led the companies to recruit people who were not trained in research and to deprive themselves of high-quality competence. I believe this is in the process of changing.

[Question] What are the objectives of the "white paper" and of the "10-year research strategy"?

[Answer] The "white paper" is not a program but a forward-looking and didactic work on the subject of what research can contribute to the solving of the country's big socioeconomic problems.

The "Strategy"--which has, to be sure, been worked out in correlation with the work on the Plan and which should shortly lead to some governmental decisions--studies certain horizontal problems: the budgetary procedures, the incentive procedures for industrial research, etc. It has some programmatic aspects: the planning for big equipment. It identifies domains given priority status, particularly those that cannot be covered by a single organism and that therefore imply the organizing of cooperation.

For we do not want to create organisms anymore. Among these domains: the nutrition sciences, which are very underdeveloped throughout the world; the biotechnologies; medicines; the effect of microprocessors on industrial activity; the possibility of making liquid fuels from sources other than oil; finally, what is perhaps the most interdisciplinary domain--analysis of the relationships between technology and employment [as published].

[Question] The revival of the research and development effort is being presented as a response to the crisis. Are we sure that technological progress is not, in the opposite way, a factor that aggravates employment phenomena?

[Answer] There is no doubt that in the absence of a revival of the research effort, the employment situation will go on deteriorating. An exporting firm's results are linked to one factor and one only: whether it puts out a research effort or not. Whether small or large, the firms that do not make this effort will see their jobs filched from them. One thing is therefore certain: without research, we shall lose 100 percent of jobs. The question

that arises is whether research, with progress in productivity, will lead to the loss of 50 percent of jobs. Or whether, as I believe, this will be more than compensated for by the growth of the market. An even more complex problem is the qualitative impact of technology on employment. On these two points, I have only some beliefs: the conviction that on balance, technological progress is positive. But there are not any quantitative studies anywhere, any precise analyses of the impact of technology on employment. This is indeed why we are making the subject a priority theme in our research "strategy."

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TRANSPORTATION

RESEARCH ON FUEL CONSERVATION DISCUSSED

Paris L'INDUSTRIE DU PETROLE GAZ-CHIMIE in French May 80 pp 53-56

/Article by Elizabeth Ratajczak-Poudou: "The Automobile and Energy Economies"/

/Excerpts/ It is now the time everywhere for energy economies. The transport sector is not in arrears. With 20 percent of the national energy consumption, this sector swallowed up about 38 Mtep in 1979. Private cars alone have devoured about 20 billion liters of fuels. The public authorities, designers and research workers have mobilized to combat these gluttons, these "devourers of energy." We see the fight against waste, a proposed vehicle consuming less than 5 liters per 100 kilometers, electronics in the service of the automobile, so many actions aiming at limiting fuel consumption. Forces are also mobilizing abroad: one speaks of consuming 8.5 liters per 100 kilometers in the United States and a FRG project would develop a prototype consuming 3.8 liters.

In 1979, the French transport sector consumed more than 35.2 Mtep or more than 20 percent of national consumption. Fuels are made up almost completely of petroleum products. Joel Le Theule, minister of transport, submitted these facts last December in the framework of a 1979 summary on energy consumption in the transport field. The latter continued its advance (+ 7.5 percent for the first 10 months of 1979) at a more sustained rate than general activity. Highway traffic increased

10.3 percent, port traffic 14.8 percent and air transport about 10 percent. Passenger traffic by highway and railroad remained the same.

According to Le Theule, the consumption figures reflect, understandably, this increased activity, but also the "undeniable effort made by the French to save energy." Consumption of gasoline and high test stabilized (17.8 Mt compared with 17.6 Mt in 1978). They even decreased at the end of the year. On its part consumption of gasohol continues to increase. It reached 9.3 Mt compared with 8.6 Mt in 1978. "Consequently the search for economies in the transport sector remains a priority." Overall consumption remains at a high level, 11 percent above that of 1973.

Highway transport is the first target. It consumes alone 72 percent of transport's total, of which 43 percent is for the private automobile, which swallows up 20 billion liters per year. For the minister of transport, economy must not be an end in itself.

We remember the Deutsch report (1976) which emphasized cooperation between the government and designers. Its objective of reducing average kilometric consumption by 20 percent by 1985 seems to be on the right path. According to the report, the impetus given to research concentrated on two main goals: efficiency and optimization of the power plant and reduction of the power required for vehicle travel.

It is a fact that since the crisis in 1973, the designers, as a whole, have improved the energy efficiency of their models and intend to continue their efforts in this direction. To achieve new progress, it will be necessary to proceed with fundamental technical changes and apply new and expensive technologies. This progress thus will prevent any substantial increase in the amounts of petroleum used for highway transport, in spite of an increase in the demand for automobiles. In the immediate future, fuel economies can be assured by the driver himself, through improving his method of driving and better maintenance of the vehicle. In the longer term, other very considerable economies can be achieved through better traffic flow* and improvements in highway networks, traffic

*According to a Swiss study, it could be possible to save up to 30 percent of fuel when crossing large intersections, if stoplights could be eliminated.

regulation as well as laws involving the maximum useful load of commercial vehicles. However, a sudden strengthening of environmental and driver safety measures could thwart the automobile industry's efforts.

What are the projects in progress today and what is the condition of research in the field of fuel economy?

Vehicles Consuming Less than 5 Liters

The AEE [expansion unknown] is attempting to stimulate innovation and technological development on new vehicles. Thus it has succeeded in convincing the Renault management and Peugeot Automobiles to develop two prototypes of vehicles consuming 25 percent less fuel, with respect to comparable models in the actual ranges.

To encourage designers to undertake prospective studies on series models, the AEE has granted a subsidy: 7 MF for Peugeot, which corresponds to 50 percent of the cost of the project and 6 MF for Renault (75 percent of the cost).

Thus, starting at the end of 1980, Renault will roll out the experimental vehicle EVE [Elements for an Economical Car]. This vehicle, which will be a testing bench for economical solutions which one could envisage applying later, was designed in the management's research department, following an agreement reached 6 months ago between AEE and the automobile designers. Compared with the Renault 18 TL, which still is already very economical, EVE must make it possible to achieve a fuel saving of more than 25 percent. This result will be obtained without any sacrifice of performance, both in the field of efficiency as well as silence, durability, comfort and, certainly, safety.

Comparative Table of Consumption (in Liters)

	90 km/h	120 km/h	City Driving
Average of vehicles competing with the R 18 TL	6.9	9.4	10.5
R 18 TL model 80	6.3	8.4	9.5
Project vehicle EVE	4.5	6	8
Minimum saving with respect to the average	35 %	36 %	24 %

To achieve this result, research developed in many directions:

Improvement of the vehicle's streamlining, whose coefficient of air penetration can still be considerably reduced.

Reducing the car's weight through the use of aluminum, plastics and steels with a high limit of elasticity;

Use of a transmission with a higher "long" ratio and automatic drive through an electronic microprocessor. This microprocessor will control both the transmission and the engine on the basis of data given by the driver and instantaneous operational conditions, in order to assure in all cases maximum power plant economy.

Reduction of resistance to tire movement.

On the request of the AEE, Peugeot Automobiles, on the part of PSA /expansion unknown/ Peugeot-Citroen, will present in Spring 1981 a research vehicle called VERA /Applied Research Economy Vehicle/, derived from the 305 GR sedan, a medium size, widely used vehicle. As at Renault, research emphasized improved streamlining--the average Cx * of European vehicles is on the order of 0.42, it will be reduced to 0.32 for the VERA project--reducing the vehicle's weight especially with the use of a light alloy (crankcase, engine, transmission case), thinner glass windows, plastic for certain equipment...In all, the VERA project shows a minimum weight loss of 100 kg compared with the 305 GR. Other adaptations are possible, as for example, cartographic ignition. It makes it possible to best adjust the spark advance for each point of engine utilization. The economy expected from cartographic ignition can range from 1 percent at a steady speed to 8 percent in the city. As regards the transmission, every increase of reduction leads to lessened consumption. That can be done by lengthening the axle ratio or by a fifth speed.

Thus the VERA project research vehicle will have the following consumptions: at 90 km/h: 4.8 liters; at 120 km/h: 6.5 liters; in city traffic: 7 liters or a reduction of average consumption of more than 25 percent compared with the 305 GR.

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*Cx: coefficient of aerodynamic drag

VERA is the prototype which Peugeot Automobiles will present in 1981. As a result of reduced weight and improved Cx, it will reduce consumption 25 percent.

Improve Conventional Engines..

The IFP has started some research projects. Since 1973, it has considerably intensified its work in the field of energy economy and especially those aiming at reducing fuel consumption. Out of a total budget of 48.37 MF devoted to energy economies in 1979, 19.1 MF have been allotted to the transport sector and 5.8 to research on fuel-electrolysis batteries. The IFP has concentrated its effort on improving conventional engines which will continue to equip almost all vehicles in the coming years. Its activity has aimed essentially at optimizing the engine-fuel-lubrication system and at the use of mathematical models which are applicable to the vehicle and the engine-vehicle combination. Thus experimental techniques and mathematical models adapted to the field of energy economy have been developed and distributed in industry and administrative technical services.

On the other hand, the Digitap [expansion unknown] system of collecting and processing data adapted to engines, includes

series for measuring thermodynamic variables and an associated minicomputer which stores and processes in almost actual time the results recorded. It is especially used for drawing up instantaneous or average pressure diagrams. It makes it feasible to precisely determine the value of the indicated efficiency and its components: rings high and low pressure.

This device is the only precise way to measure an engine's mechanical losses.

Moreover, the IFP has developed models for simulation, making it possible to indicate all the internal phenomena in a cylinder. These mathematical instruments make it practical to describe and foresee the development of normal combustion, conditions where knocking appears, heat exchanges to the walls, the thermal balance of the energy introduced in the engine. This use of models has also allowed an analysis of losses, estimating the potential interest of new procedures such as that of the chamber with a stratified pressure, the development of a so-called new method "of four octane indices" which precisely carries out the engine-fuel adjustment etc. In addition, programs have been developed to foresee, on the basis of engine tests, the actual operation of a vehicle as regards fuel consumption and pollutant emission. This instrument especially permits estimating the influence of certain factors, which are difficult to show through measurements on the vehicle: characteristics of the fuel and the lubricant, rate of compression, underutilization of engine power etc.

...As Well as Combustion

In addition to the development of general methods, IFP has directed its work towards improvement or modification of combustion techniques. Projects have made it possible to select the most promising methods to improve the operation of engines with partial loads and estimate the corresponding improvements in consumption during standardized cycles. Thus the combination of many methods such as reduction of richness, increase of compression rates, use of improved lubricants, could allow improvements in efficiency on the order of 20 percent in city traffic. As regards combustion in a homogeneous atmosphere, relatively simple technological changes involving feed, inlet and ignition systems could provide an improved efficiency of 5 to 10 percent in engines of the present series. On the other hand, the ability to operate with a poor mixture would be improved with new types of combustion chambers with very high compression rates.

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CURRENT AIRBUS INDUSTRY REVIEWED

Gelsenkirchen AEROKURIER in German Jun 80 pp 700-701

[Article by Ralf Nolting]

[Text] Airbus Chief Bernhard Lathière was euphoric as usual. Just as if he were negotiating the purchase from Boeing. One day before the opening of the International Air Traffic Exhibition, the international press had crowded to the airbus industry. The Frenchman, who was everlastingly smoking cigars, first of all excused himself to the press: since the last ILA (International Air Traffic Exhibition), he had to sell so many aircraft, that he had been unable to learn German again. However, it may now justifiably be expected that Lathière will speak German perfectly at the ILA 1982. Because in the future things will not progress as stormily as in the years 1978 and 1979 - during this time, the sales figures jumped from 100 to 400 units. The development of the sales data was the real news concerning the airbus industry in Hannover. Besides statements concerning the planned increase of production rates, news concerned airbus family planning and the status of technical improvements on the proven A300 model.

"It is quite clear," said Bernhard Lathière in Hannover, "that in 1980 we will sell fewer airbuses than in 1979."

An airline, such as, for example, the Lufthansa, purchases a package of 50 A310s only once. To quote Lathière: "Nearly all the big deals have been made. We are represented on all five continents, and we are especially proud to have broken into the Japanese, Australian, and Brazilian market." But the airbus salesman wanted to put special stress on the regions of Asia, Africa, the Gulf states, and South America. Up to now, 33 airbus customers have been won over. According to Lathière's estimates, these represent a potential market of 800 to 900 aircraft of the type A300 and A310. However, the airbus industry is very determined to exceed this figure and to expand further its sales potential. In particular, by creativity and healthy aggressiveness, as could be read in the press releases.

Investment Problems

He who wants to sell must also be able to deliver. As regards the production rate, so said Felix Kracht, responsible for production with the airbus industry, this is mainly an investment problem. All the airbus partners would at this time make substantial investments in order to run up the production rate from the present three aircraft monthly to eight in the year 1984. Already one year later, that is in 1985, the plan calls for ten of the European "fat bellies" to leave the final assembly hall in Toulouse every month. As regards the labor forces, according to Kracht, this presents no problem in view of the 150,000 employees in the European aircraft industry. Only 18,000 people participate in the airbus program, so that a sufficiently large potential - mainly from the military area - is still available.

Family Planning Continues

As regards the airbus family planning, the following was discovered in Hannover: The first objective is supposed to be to make the A310 ready for mass production. Then comes the elongated variant of the A300B4, namely the TA9, a two-aisle aircraft with 310 to 350 seats for short and medium distances. It is supposed to bring significant economic advantages as compared to the presently flying tri-jets of this size category.

The TA11 was named in Hannover as number 2 in the sequence. This is a 210-seat multiple jet, which is supposed to replace the currently used 4-engine narrow-fusilage aircraft, called narrow-body in the airline jargon (707, DC-8, Coronado). Range: 11,100 km (6000 NM). Number 3 on the priority list: the single aisle (SA = single aisle) series offered as SA I with 130 seats, SA II (160 seats) and SA III with 180 seats This aircraft is supposed to be the technological non plus ultra and is supposed to replace the present generation of similar large narrow bodies. The airbus management thought that it was still possible to start the program this year.

The A300 Ever More Powerful

One point to which the airbus representatives in Hannover referred with a certain - and also justified - pride was the optimization of the A300B2 and B5, as far as weight, range, and flying performance were concerned. The original A300B2 (now called the A300B2-100) was delivered to Air France in May 1974. It had a maximum starting weight of 137 tons with a range of 2600 km (1400 NM). The result of normal development tests then showed that the maximum takeoff weight (MTOW) could be increased to 142 tons. This version was then called A300B2-200. It offers the aircraft owner increased range and/or increased useful load. This naturally implies greater operating flexibility.

The same holds for the A300B4, for which a maximum starting mass of 150 tons was originally specified, and which, with this weight, had a range of 3885 km (2100 NM). This starting weight was first increased to 157.5 tons with a range of 5090 km (2750 NM). This corresponds to the present A300B4-100. The first A300B4-200 with 165 tons maximum allowed starting mass and a range of 5735 km (3100 NM), was delivered to Air France at the end of April 1979.

More Useful Load - Increased Flexibility

In comparison with the first A300, present-day airbuses represent a whole spectrum of improvements: for example, the increase of the structural useful load by 3.7 tons; then a range that has been increased by 1440 km (780 NM), with a useful load of 300 passengers; a range increased by 553 km (300 NM) from limited starting runways and a useful load increased by 14.5 tons on limited landing runways. These increased design weights increase the destination possibilities of the airlines and increase the so-called multi-stop flexibility of the aircraft.

Reliability Quota at 99 Percent

On the part of the airbus industry, it was emphasized in Hannover that all A300s were delivered to the customers with a weight that was 0.6 percent lower and a specific range that was 7 percent higher than the guaranteed values. Another point of interest: The experience which the aircraft companies have had with the A300 confirmed the outstanding regularity and reliability of this aircraft. The reliability quota is presently somewhere above 98 percent for the entire fleet and more than 99.7 percent for the three top airlines. The time intervals for maintenance inspections have therefore been considerably extended. As a result, maintenance costs have been fundamentally reduced, and therefore the economy of the business has been improved. The initial interval of 75 hours for check A has risen to 200 hours, and the 300 hour interval for check B can now be skipped entirely. The 1200 hours set for check C could be extended to 2000 hours.

The Lowest Seat-Kilometer Costs

Now as before, the airbus has the most advanced subsonic wing of all operating aircraft. Aircraft companies which are already flying the A300 conclude from this that this aircraft has the lowest seat-kilometer cost in comparison to all other short and medium distance aircraft. The twin jet A300 consumes 10 to 15 percent less fuel per seat, over comparable distances, as its triple-jet competitive aircraft of the wide-space class. The narrow body aircraft for short and medium distances of the old generation consumed about 40 percent more fuel per seat than the European twin of the airbus industry. The possibility of saving fuel with the airbus is a point of survival importance for many aircraft companies.

Austrian Airlines has now decided in favor of the small airbus, more precisely the A310-220. For the Austrian Airline, the A310 is the first wide-space jet which it will put into service. Two machines are firmly on order, and options exist for two more.

A Coming Conflict: Forward Facing

Naturally, the topic of the forward facing crew cockpit (FFCC) could not be neglected by the airbus industry at ILA. An essentially functional mock-up of this new cockpit generation - as was discovered in Hannover - is currently being demonstrated to the airlines in Toulouse. It will shortly be presented to the public. During the airbus press conference, one spoke of the "turning point in cockpit technology". In the holy of holies of commercial flying, "page flipping" will once and for all have an end in the forward facing concept. Electronic data acquisition, processing, and display (monitors) will free the crews from straining their memories and will free their thoughts for flight management. Airbus wants to offer the airlines an optimized cockpit with deployment of the A310. This can be operated by two pilots. Flight engineers present in Hannover expressed vehement criticism against the FFCC and especially deplored that those who were directly affected, namely the pilots and the flight engineers, were scarcely consulted in planning the new cockpit technology.

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